OCEANIC BIOLUMINESCENCE AND MARINE BIOLOGY

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LONG TERM GOALS

Steven Haddock has been selected as an AASERT Fellow to conduct thesis research on bioluminescence in related to oceanographic issues. This project strives to understand how luminescence naturally occurs in the ocean, specifically in relation to marine snow, expression by plankton, and in-situ expression of light. Marine snow is the major component of the oceanic environment, and this research aims to determine how the flux of material through marine snow would be altered by concentrations of luminous organisms. There is a great diversity of expression of luminescence, and our aim in investigating particular species was to characterize the color, intensity and patterns of some of the brightest luminous species. We also hope to understand how much of a factor bioluminescence is in “normal” plankton interactions.

OBJECTIVES

This project has two components: laboratory and field experiments. Laboratory experiments will test whether zooplankton are attracted to or repulsed by bioluminescent marine snow. Both bioluminescent and chemical cues will be tested as possible zooplankton aggregating mechanisms to regions of dense phytoplankton and marine snow. Field experiments will determine associations between bioluminescent intensity, microscale turbulence, marine snow concentrations, fluorescence measurements, and zooplankton abundances in water column profiles in both open ocean and coastal waters.

APPROACH

Grazing experiments using phytoplankton-based marine snow incorporated with bioluminescent and non-bioluminescent dinoflagellates will be one approach to test zooplankton reactions to bioluminescent marine snow. Low-intensity light videography will be a second and separate determination of attraction or repulsion reactions. As the next stage of experiments, "thin layers" will be simulated in the laboratory by salinity-layered tanks incorporated with bioluminescent or chemical cues related to phytoplankton or marine snow thin layers. Zooplankton distributions, recorded by an infrared camera, in the tanks will be determined relative to the layers.

WORK COMPLETED

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Laboratory progress includes building prototype thin layer tanks during the first months of this grant to test longevity and mixing rates of the layers, and zooplankton natural behaviors in the tanks. A wide variety of zooplankton were tested to see which would be most behaviorally conducive to tank experiments. A preliminary 24-hour behavior experiment was done with *Calanus pacificus,* the most abundant local copepod in the Santa Barbara Channel. Analysis of the time-lapse videos is in progress to statistically determine location and behavior of the copepods in the tanks over this time period.

Data from June 1995 in the Santa Barbara Channel is being pooled and analyzed to identify associations between bioluminescent organisms, marine snow, microscale turbulence, and zooplankton using a bathyphotometer (MOORDEX-3), marine snow still-camera profiler and temperature-gradient microstructure profiler. (SCAMP). These detectors will be deployed together in the future to further test the hypothesis that marine snow and bioluminescence collect in certain areas of the water column depending on the turbulence levels. Tentative plans are made to attend several CalCOFI cruises with this equipment in 1998. A cruise is scheduled in East Sound, WA with other ONR-funded thin-layer researchers, including Alldredge and MacIntyre, in May 1998.

RESULTS

Distributions of bioluminescence intensity, microscale turbulence, marine snow concentrations, and zooplankton abundances were measured in the Santa Barbara Channel over three days in June 1996. The MOORDEX-3 bathyphotometer was used to collect bioluminescence measurements. Zooplankton samples were collected by SCUBA divers with nets at preselected depths based on turbulence profiles collected by a temperature-gradient microstructure profiler (SCAMP). Preliminary analysis indicates that marine snow and bioluminescence peaks were co-occurring at the thermocline at two out of three stations examined. Zooplankton maxima were not associated with marine snow peaks, but eggs were found to be 4-60x more concentrated in the thermocline than at sampling stations above this region. The rate of dissipation of turbulent kinetic energy was below detection at the peak of bioluminescent intensity. This bioluminescent peak was located immediately below the surface wind-mixed layer, which penetrated to a depth of 7 m. Almost no bioluminescence was recorded in the surface mixed-layer where energy dissipation was highest.

IMPACT

Patchiness is a common distribution pattern for pelagic plankton. Therefore, the oceanic pelagic zones should be increasingly viewed not as a homogeneous ecosystem, but as having important "microscale" structure. This patchiness requires observing plankton, the location of their food sources, and the physical forces and sensory attractions that shape their distributions with finer resolution than previous observations. If zooplankton are found to be attracted to thin layers, then the presence of organisms in regular occurrence at these layers could affect SONAR measurements if organisms with swim bladders or other sound-scattering structures are present in great numbers in these layers.

TRANSITIONS AND RELATED PROJECTS

A small prototype bathyphotometer under development in the Case laboratory will be tested and used for profiling of bioluminescence to test if there is a correlation of bioluminescence with phytoplankton or marine snow thin layers. Information gained reguarding biological fine structure of coastal waters can be anticipated to have value in Naval operations involving optical and acoustic measurements.